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# Ten Years of Data for Four Cyprinid Species in Lake 114, an Experimentally Acidified Lake in the Experimental Lakes Area, Northwestern Ontario

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Fisheries and Aquatic Sciences 733

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by

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## ABSTRACT

Chalanchuk, S.M., L.C. Mohr, and D.J. Allan. 1988. Ten years of data for four cyprinid species in Lake 114, an experimentally acidified lake in the experimental lakes area, northwestern Ontario. Can. Data Rep. Fish. Aquat. Sci. 733: iv + 23 p.

Length-frequency distributions and catch data are presented for four species of Cyprinidae in Lake 114, in the Experimental Lakes Area, northwestern Ontario: fathead minnow (Pimephales promelas), pearl dace (Semotilus margarita), northern redbelly dace (Phoxinus eos), and finescale dace (Phoxinus neogaeus). Lake 114 received monthly additions of sulphuric acid ($H_2SO_4$) from July 1979 until October 1986. Data presented in this report are from 1978 and 1980 to 1988. Maximum fork lengths attained by each species were 133 mm by pearl dace, 89 mm by fathead minnow, 85 mm by northern redbelly dace, and 97 mm by finescale dace. These lengths are compared to those of other North American populations.

Key words: Pearl dace; fathead minnow; finescale dace; northern redbelly dace; fork length; pH; acidification.

## RÉSUMÉ

Chalanchuk, S.M., L.C. Mohr, and D.J. Allan. 1988. Ten years of data for four cyprinid species in Lake 114, an experimentally acidified lake in the experimental lakes area, northwestern Ontario. Can. Data Rep. Fish. Aquat. Sci. 733: iv + 23 p.

On présente les distributions de fréquence de longueurs et les données sur les prises pour quatre espèces de cyprinidés provenant du Lac 114 de la Région des Lacs Expérimentaux du nord-ouest de l'Ontario: le tête-de-boule (Pimephales promelas), le mulet perlé (Semolitus margarita), le ventre rouge du nord (Phoxinus eos) et le ventre citron (Phoxinus neogaeus). Le Lac 114 a fait l'objet d'additions mensuelles d'acide sulfurique ($H_2SO_4$) de juillet 1979 à octobre 1986. Dans le présent rapport on présente des données pour 1978 et pour 1980 à 1988. Les longueurs à la fourche maximales enregistrées pour chacune des espèces ont été les suivantes 133 mm pour le mulet perlé, 89 mm pour le tête-de-boule, 85 mm pour le ventre rouge du nord et 97 mm pour le ventre citron. Ces valeurs sont comparées à celles obtenues pour d'autres populations de l'Amérique du Nord.

Mots-clés : mulet perlé; tête-de-boule; ventre citron; ventre rouge du nord; longueur à la fourche; pH; acidification.

## INTRODUCTION

The purpose of this report is to present data on the fish populations in Lake 114, the Experimental Lakes Area (ELA), northwestern Ontario. Fish species present in Lake 114 are fathead minnow (Pimephales promelas), pearl dace (Semotilus margarita), northern redbelly dace (Phoxinus eos), and finescale dace (Phoxinus neogaeus). (Scientific names of fishes in this report are based on American Fisheries Society, 1980). These four species are the most widespread and abundant species in the ELA (Beamish et al. 1976), and are distributed throughout a large part of North America (Scott and Crossman 1973). They are a significant food source for many larger fish (Scott and Crossman 1973), such as lake trout (Salvelinus namaycush), and thus constitute an important component of many aquatic ecosystems.

Recently, researchers have shown that many species of Cyprinidae are very sensitive to acidification (Rahel and Magnuson 1983; Mills and Schindler 1985; Pauwels and Haines 1986). Based on these studies, the pH values below which these species do not occur are 5.8 - fathead minnow, 5.3 - pearl dace, northern redbelly dace, and finescale dace. However, deleterious effects on these populations occur at higher pH values. For example, in a whole-lake acidification experiment in Lake 223, in the ELA, fathead minnows failed to reproduce at a pH of 5.9 (Mills 1984; Schindler et al. 1985; Mills et al. 1987).

In Lake 223, varying volumes of sulphuric acid were added to the lake as required to maintain pH at a constant target value each year (Cruikshank 1984). In Lake 114, fixed volumes of sulphuric acid were added to the lake at monthly intervals (Cruikshank 1984) and pH was not maintained at a constant value each year. The initiation of the Lake 114 acidification experiment in 1979 provided an opportunity for monitoring the population dynamics of the fish populations in response to acid "pulses" rather than to relatively constant acid inputs to the lake as had occurred in Lake 223. We hypothesized that the acidification of Lake 114 would have detrimental effects, such as reproductive impairment and population decline, on the acid-sensitive species of fish, especially fathead minnow, similar to those that occurred in Lake 223 (Mills et al. 1987).

In this report we present length-frequency data and catch data for the Cyprinidae in Lake 114 for 1978 and 1980 to 1988. Maximum lengths attained by each species in Lake 114 are compared to those for ELA lakes and other North American populations.

## MATERIALS AND METHODS

Lake 114 is a small, shallow lake (area = 12.1 ha, maximum depth = 5.0 m, mean depth = 1.7 m) in the Experimental Lakes Area. Information on the background chemistry and morphometry are found in Armstrong and Schindler (1971); Brunskill and Schindler (1971); and Cleugh and Hauser (1971).

Electrolyte grade sulphuric acid (36N $H_2SO_4$) was added to Lake 114 at monthly intervals during the open-water seasons from July 1979 until October 1986. Each month 33.6 L of acid were added to the surface of the lake using the "Prop-tube mix" method (Cruikshank 1984; 1986). This constant volume of acid was chosen to simulate monthly precipitation events at a pH one unit lower than the natural pH of rain on the lake (Schindler and Turner 1982). Mean surface pH decreased by 0.30 to 0.60 units after each acid addition, then gradually increased between additions. The time-weighted mean epilimnetic pH of Lake 114 varied from year-to-year throughout the acidification experiment, ranging from 5.65 to 6.26 (Cruikshank 1984; 1986). However, the mean pH has not substantially changed from background values. Mean epilimnetic pH of 6.11 in 1987 (D.R. Cruikshank, Freshwater Institute, Winnipeg, Manitoba, pers. comm.), the first year without acid additions, was similar to the pre-acidification value of 6.18 in 1978.

Fish were captured intermittently from May to October 1978 and April to October 1980 to 1988. Data for 1979 were presented by Tallman et al. (1984). Fish were primarily captured with modified versions of Beamish-style trap nets (Beamish 1972). These nets were equipped with pots having mesh sizes of 0.8, 1.6, or 3.2 mm. Trap nets were usually set for overnight periods. Standard wire-mesh minnow traps (mesh size 5 mm) were used in July 1982 to supplement trap net catches, and in April 1983 and April 1984 to sample fish under the ice. Catches of less than 1500 fish were sampled completely. However, catches of several thousand fish were common and these were subsampled.

Immediately after capture, fish were transported live to the field laboratory, anaesthetized with methane tricaine sulphonate (MS222), and measured for fork lengths (mm). Length-frequency distributions were constructed for monthly intervals each year for each species. Graphs were constructed if sample sizes were greater than nine fish.

Species catch composition was presented annually by calculating total catch for each species as a percentage of the entire annual catch of fish of all species. Catch-per-unit-effort (CPUE) was determined for each species based on total annual catches. One trap net set for one overnight period constituted one unit of effort.

## ACKNOWLEDGMENTS

We would like to thank Ken Mills for his guidance and help throughout the study. Constructive criticisms by John Babaluk, Drew Bodaly and Everett Fee are appreciated.

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Table 1. Maximum fork lengths of four species of Cyprinidae in Lake 114, ELA lakes; and other North American populations. Numbers in parentheses refer to number of populations.

| Lake | Location | Pearl dace | Fathead minnow | Northern redbelly dace | Finescale dace | Reference |
|---|---|---|---|---|---|---|
| 114 | ELA | 133 | 89 | 85 | 97 | - |
| 111 | ELA | 96 | 65 | - | 76 | - |
| 222 | ELA | 100 | - | - | - | - |
| 223 | ELA | 166 | 88 | - | 76 | - |
| 224 | ELA | 116 | 68 | - | 83 | - |
| 226 | ELA | 134 | 89 | - | - | - |
| 227 | ELA | - | 65 | 59 | - | - |
| 260 | ELA | 148 | 75 | 78 | - | - |
| 302N | ELA | 125 | 91 | 93 | 104 | - |
| 302S | ELA | 127 | 101 | 88 | 90 | - |
| 303 | ELA | 82 | 65 | 75 | 59 | - |
| 373 | ELA | 93 | - | 68 | 87 | - |
| 375 | ELA | 116 | 62 | - | 68 | - |
| 382 | ELA | 120 | 75 | - | 65 | - |
| NB(1) | Nebraska | 89[a] | - | - | - | Stasiak 1978a |
| ND(9) | N. Dakota | - | 79[b] | - | - | Held and Peterka 1974 |
| MN(1) | Minnesota | - | - | - | 85[a] | Stasiak 1978b |
| QU(1) | Quebec | 120[b] | - | - | - | Lalancette 1977 |
| NA(3) | N. America | 158[b] | 94[b] | 61[a] | - | Scott and Crossman 1973 |
| ON(11) | Ontario | 160 | 83 | 91 | 98 | Mohr 1986 |
| ON(1) | Ontario | 106[a] | 73[a] | - | - | Chadwick 1976 |

[a] Standard length

[b] Total length

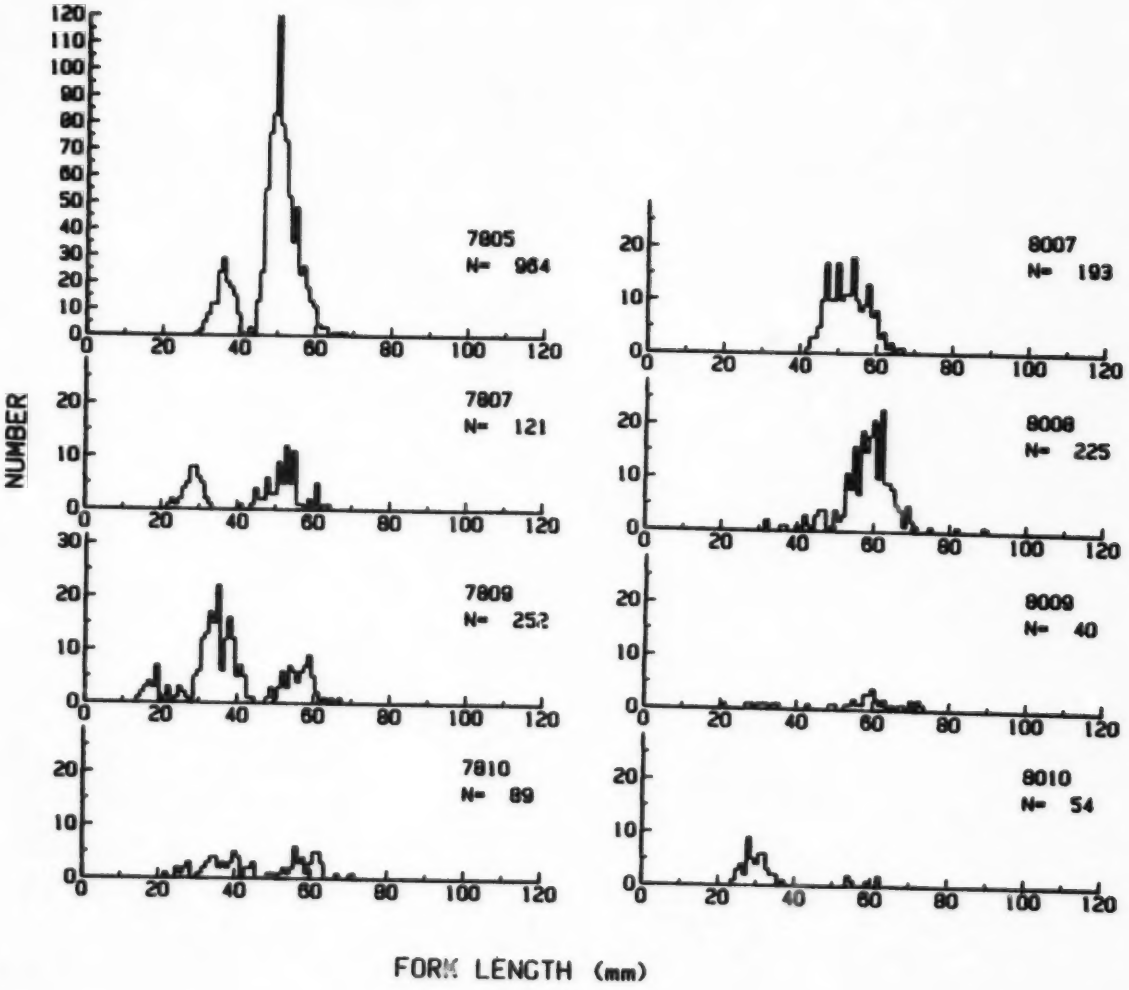


Figure 1a. Monthly length-frequency distributions for fathead minnow in Lake 114. All fish were caught by trap net. Note change in scale of y-axis for May 1978 (7805).

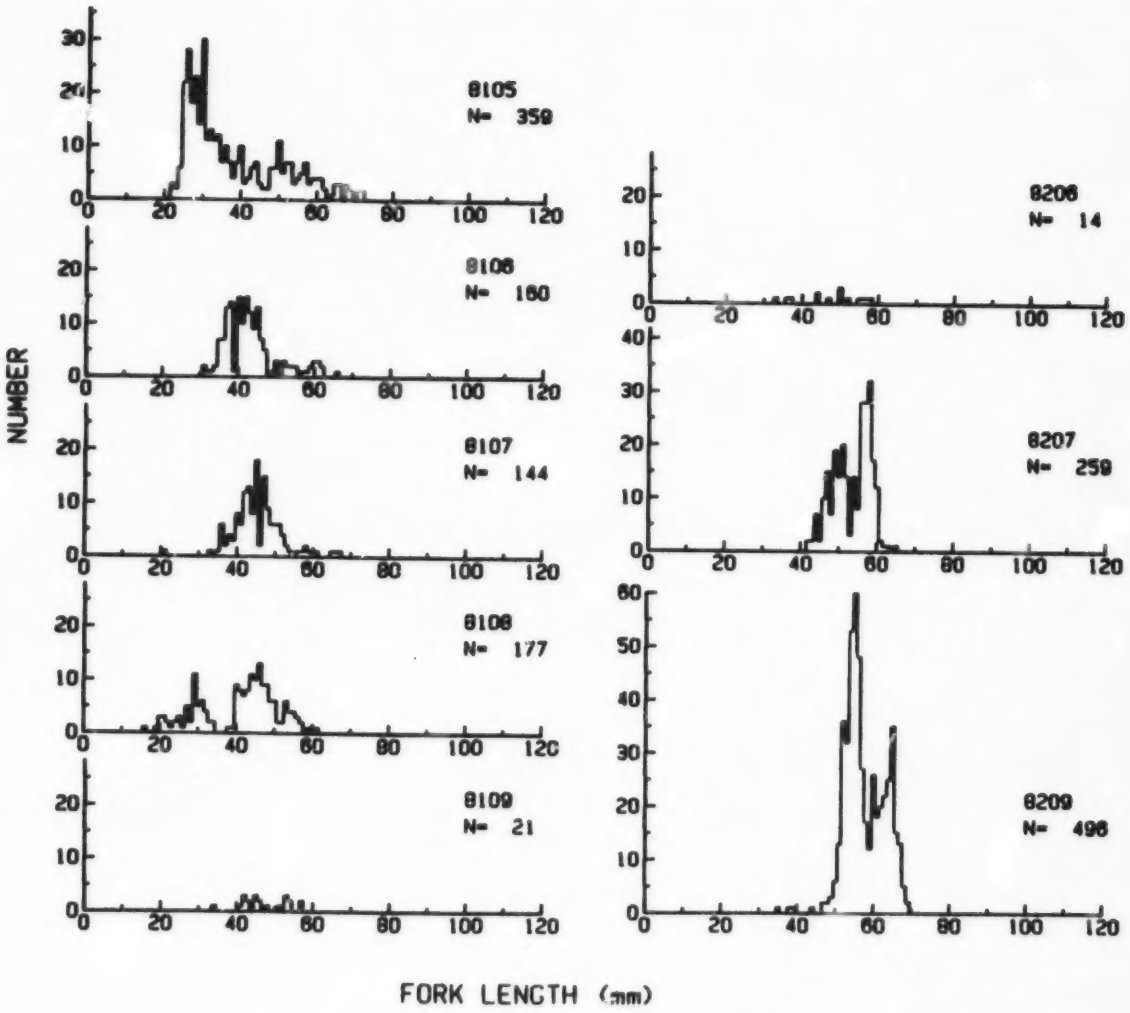


Figure 1b. Monthly length-frequency distributions for fathead minnow in Lake 114. All fish were caught by trap net.

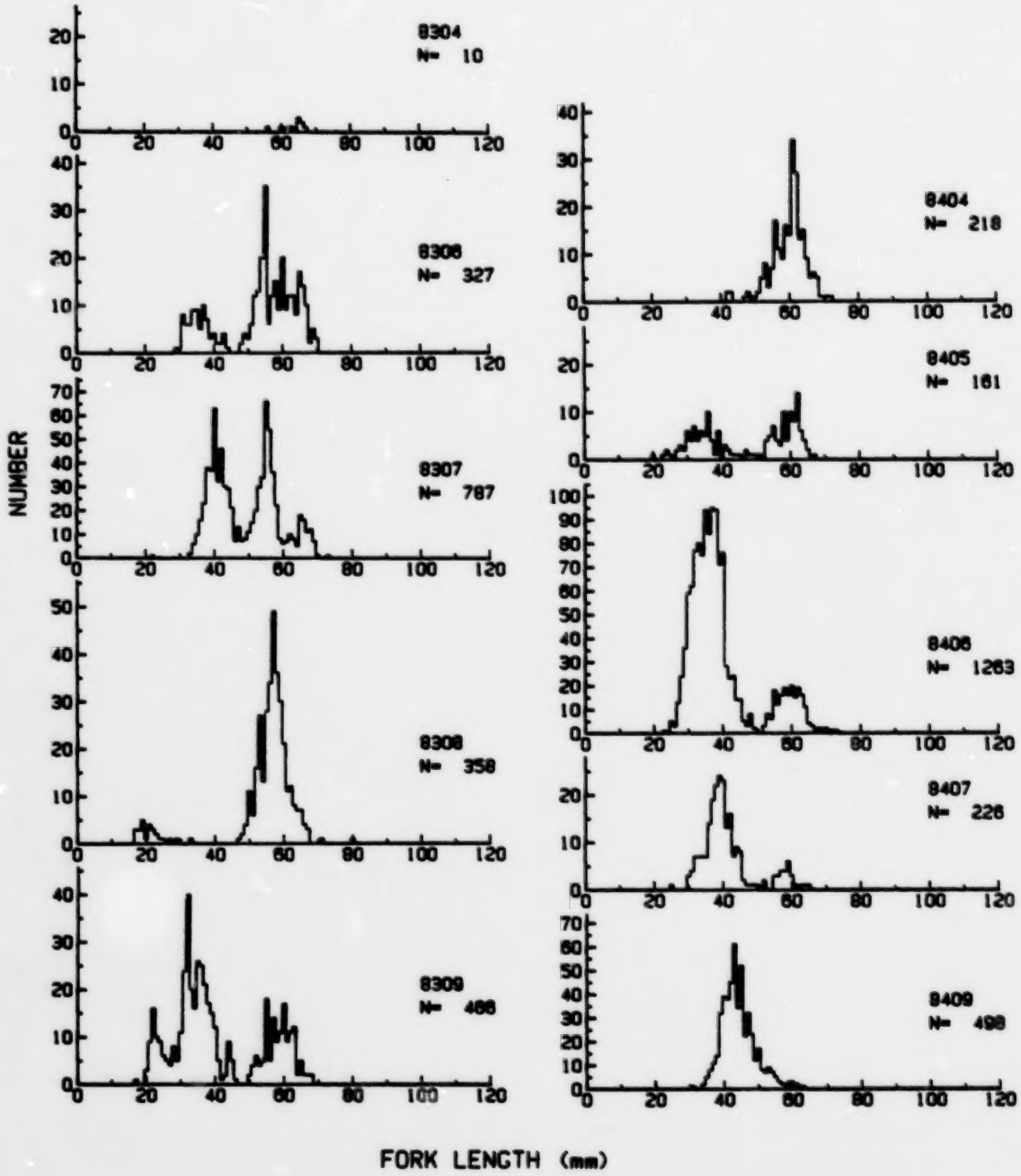


Figure 1c. Monthly length-frequency distributions for fathead minnow in Lake 114. Fish captured during April 1983 (8304) and April 1984 (8404) were caught by minnow trap. All other fish were caught by trap net. Note change in scale of y-axis for July 1983 (8307), June 1984 (8406), and September 1984 (8409).

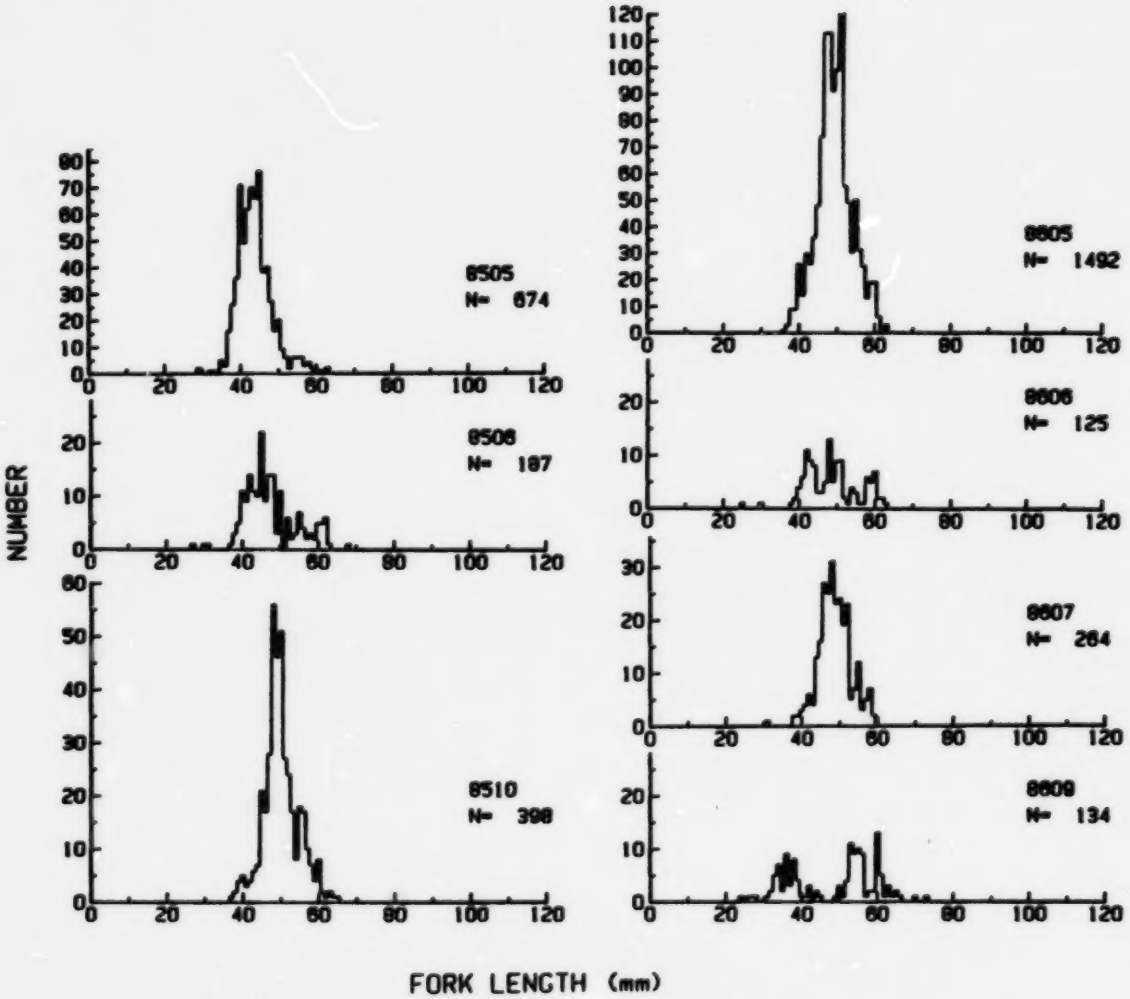


Figure 1d. Monthly length-frequency distributions for fathead minnow in Lake 114. All fish were caught by trap net. Note change in scale of y-axis for May 1985 (8505) and May 1986 (8605).

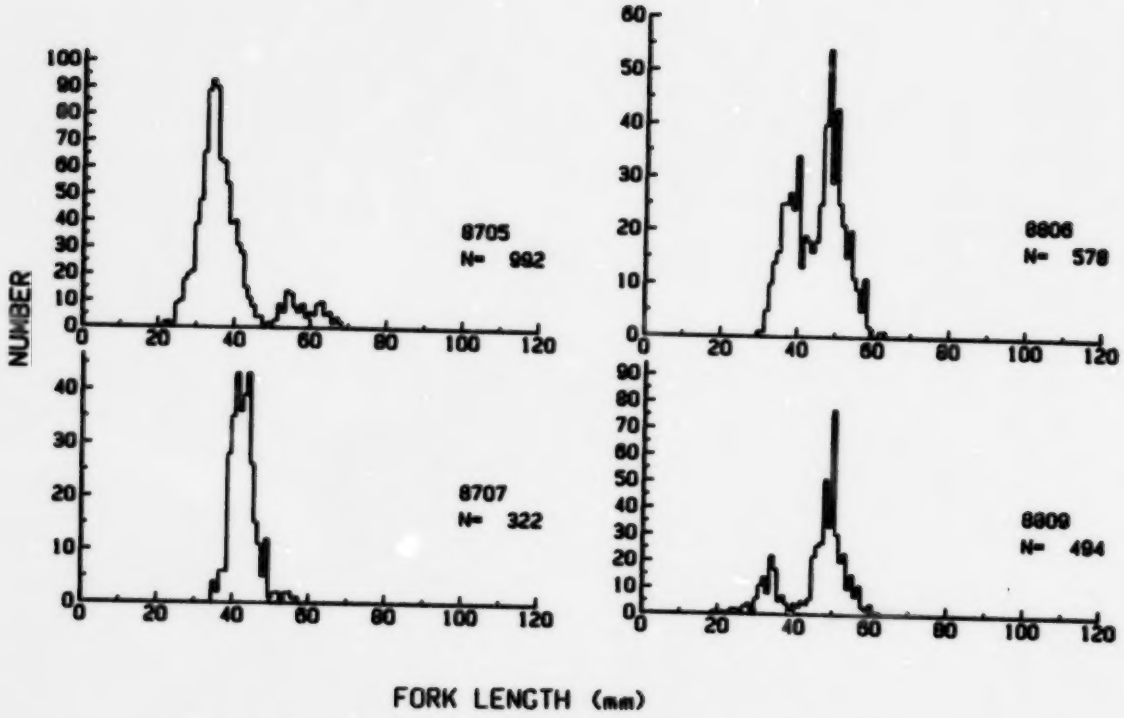


Figure 1e. Monthly length-frequency distributions for fathead minnow in Lake 114. All fish were caught by trap net. Note change in scale of y-axis for May 1987 (8705) and September 1988 (8809).

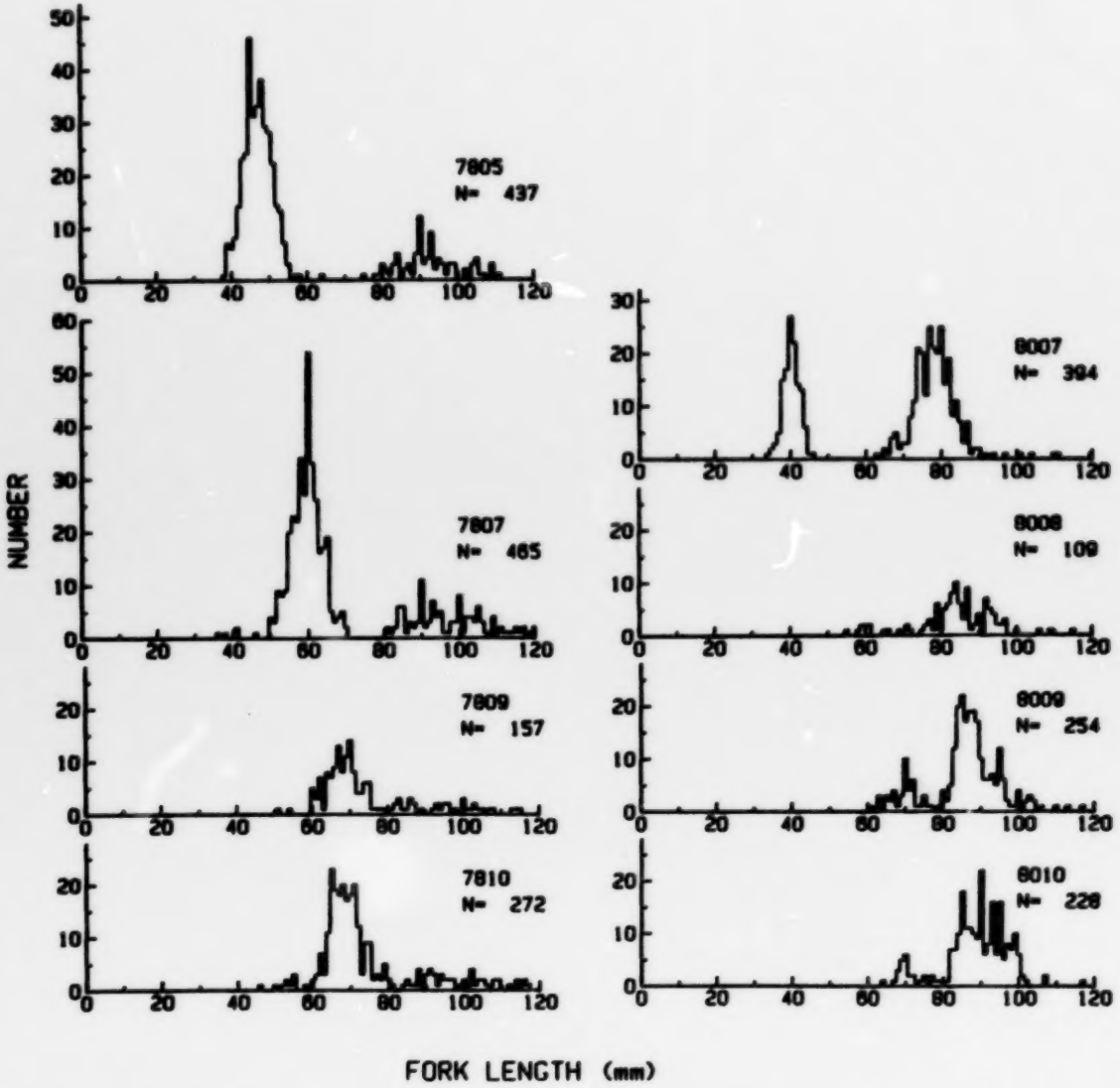


Figure 2a. Monthly length-frequency distributions for pearl dace in Lake 114. All fish were captured by trap net.

Figure 2b. Monthly length-frequency distributions for pearl dace in Lake 114. Fish captured during July 1982 (8207) were caught by minnow trap. All other fish were caught by trap net.

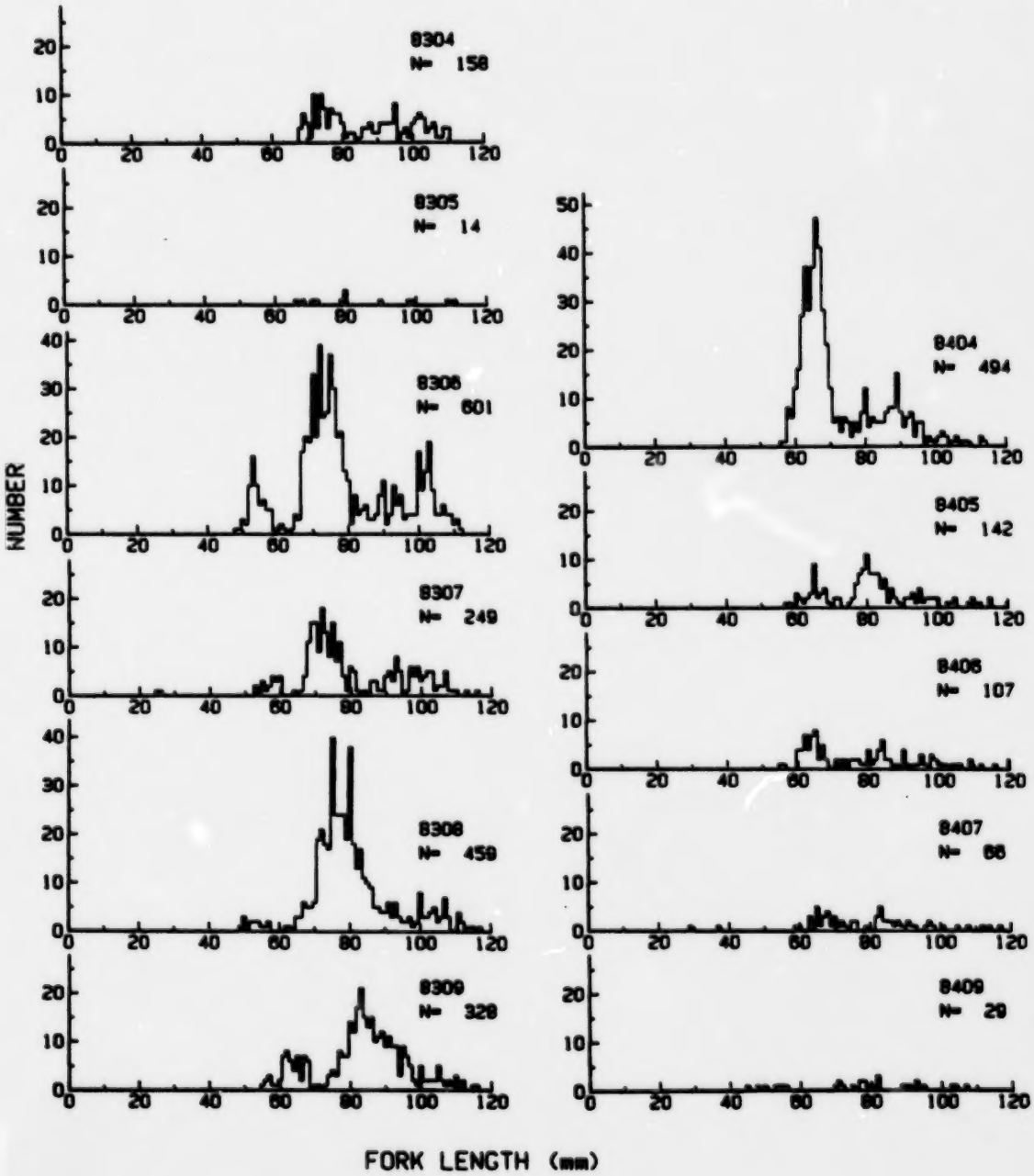


Figure 2c. Monthly length-frequency distributions for pearl dace in Lake 114. Fish captured during April 1983 (8304) and April 1984 (8404) were caught by minnow trap. All other fish were caught by trap net.

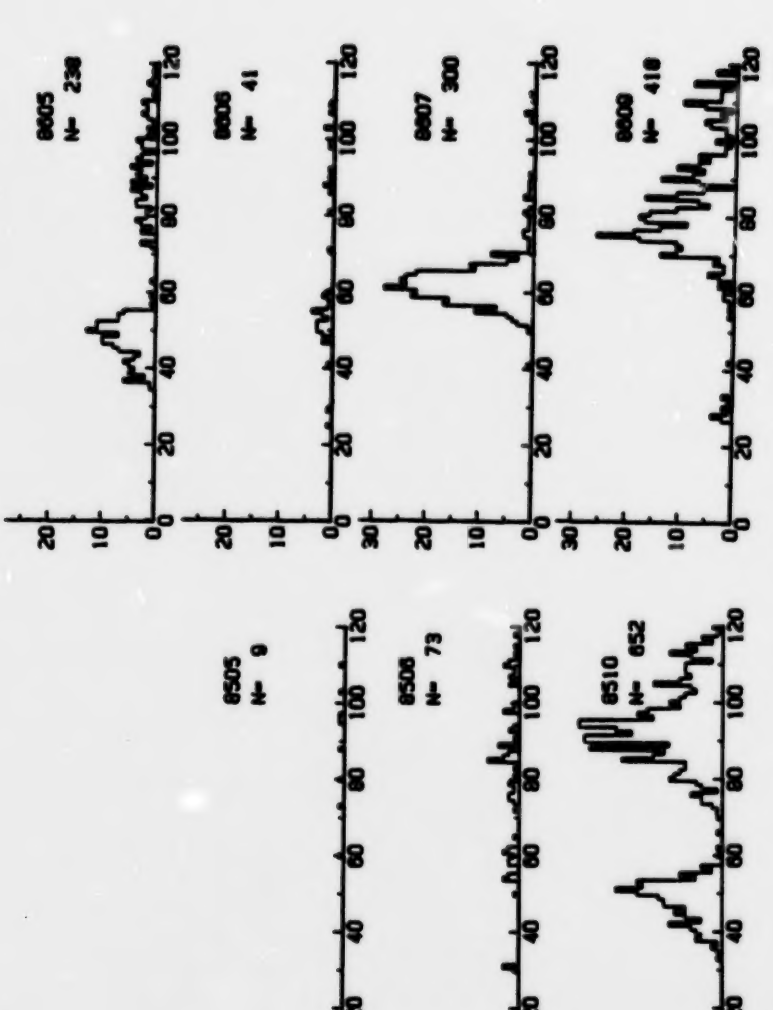


Figure 2d. Monthly length-frequency distributions for pearl dace in Lake 114. All fish were captured by trap net.

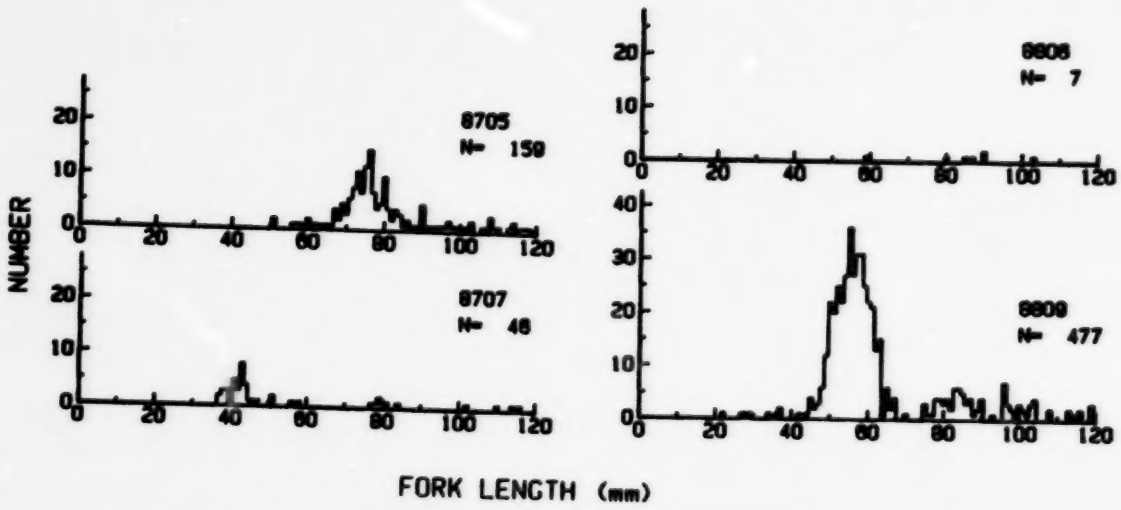


Figure 2e. Monthly length-frequency distributions for pearl dace in Lake 114. All fish were captured by trap net.

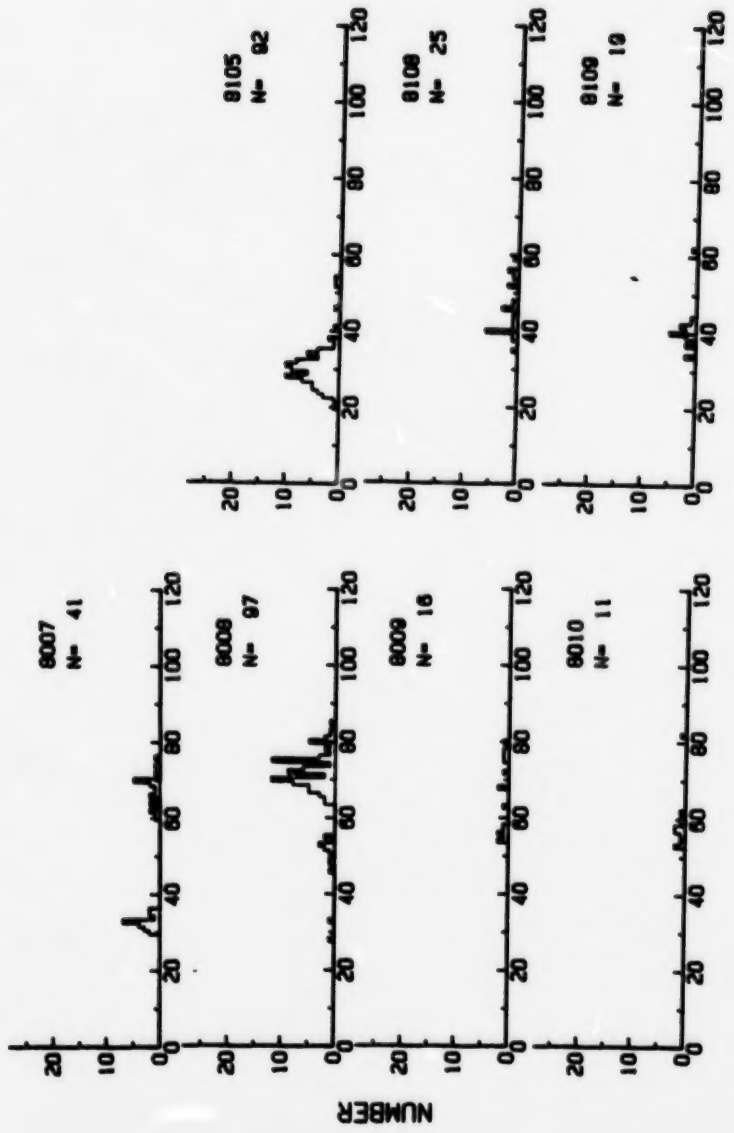


Figure 3a. Monthly length-frequency distributions for northern redbelly dace in Lake 114. All fish were captured by trap net.

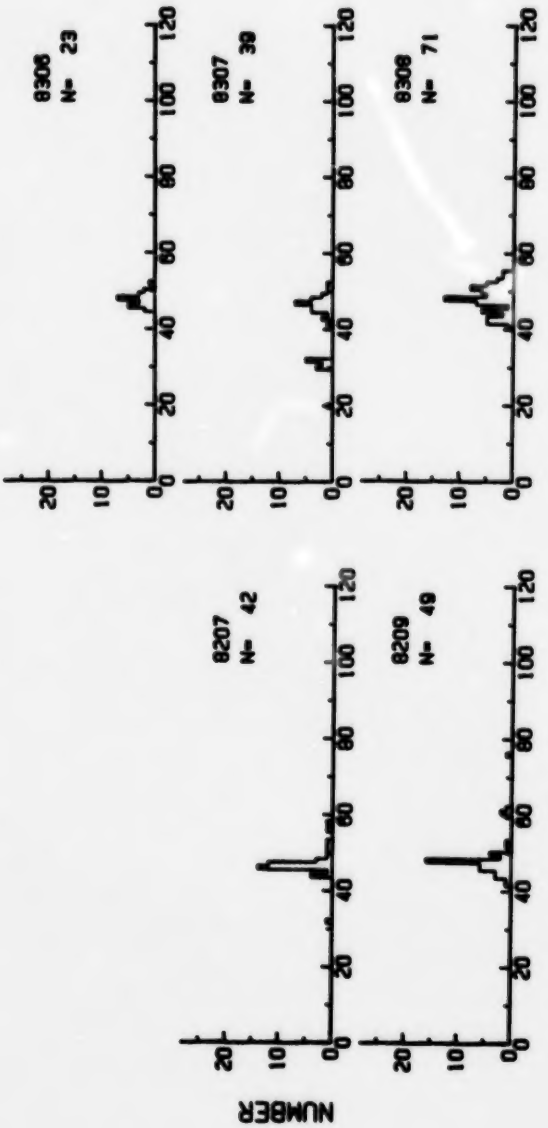


Figure 3b. Monthly length-frequency distributions for northern redbelly dace in Lake 114. All fish were captured by trap net.

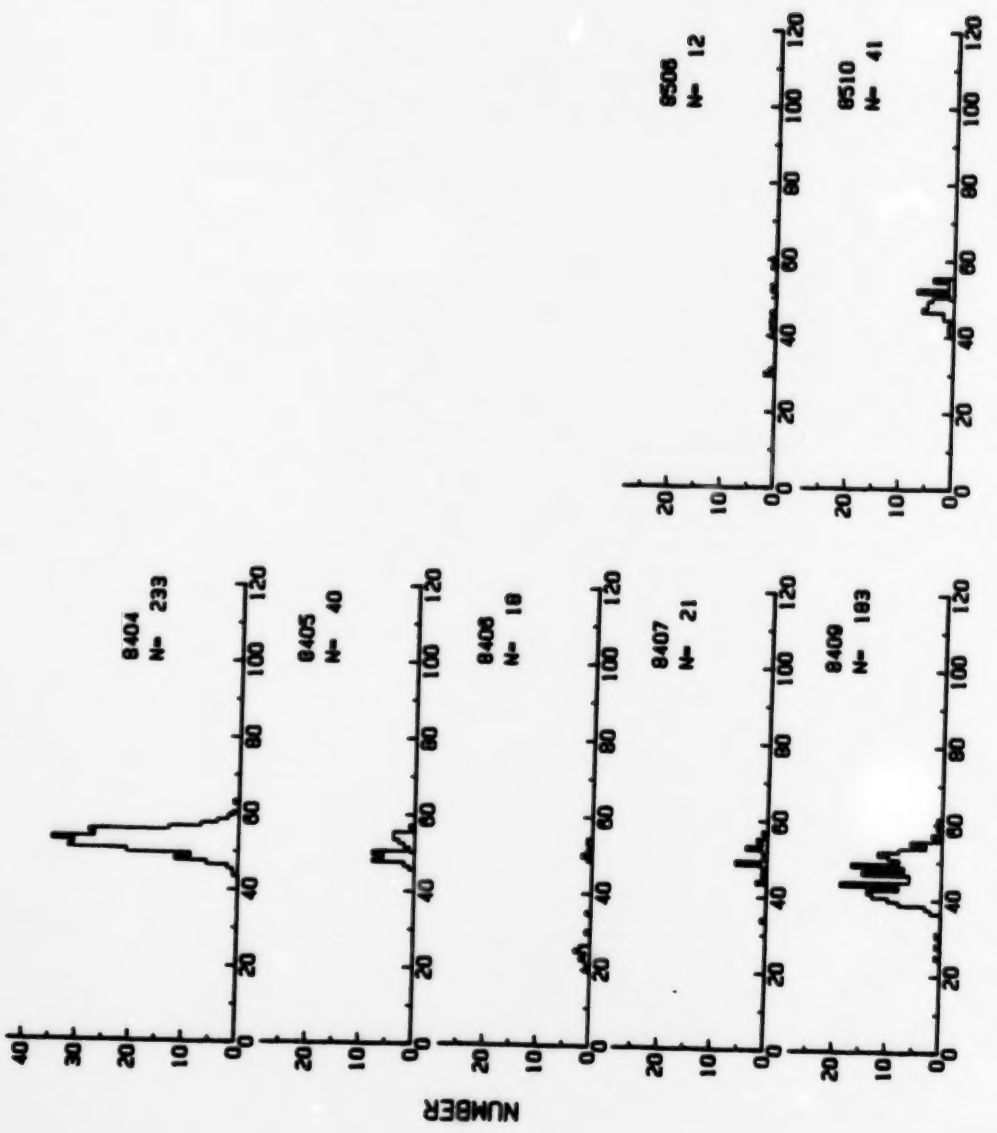


Figure 3c. Monthly length-frequency distributions for northern redbelly dace in Lake 114. Fish captured during April 1984 (8404) were caught by minnow trap. All other fish were caught by trap net.

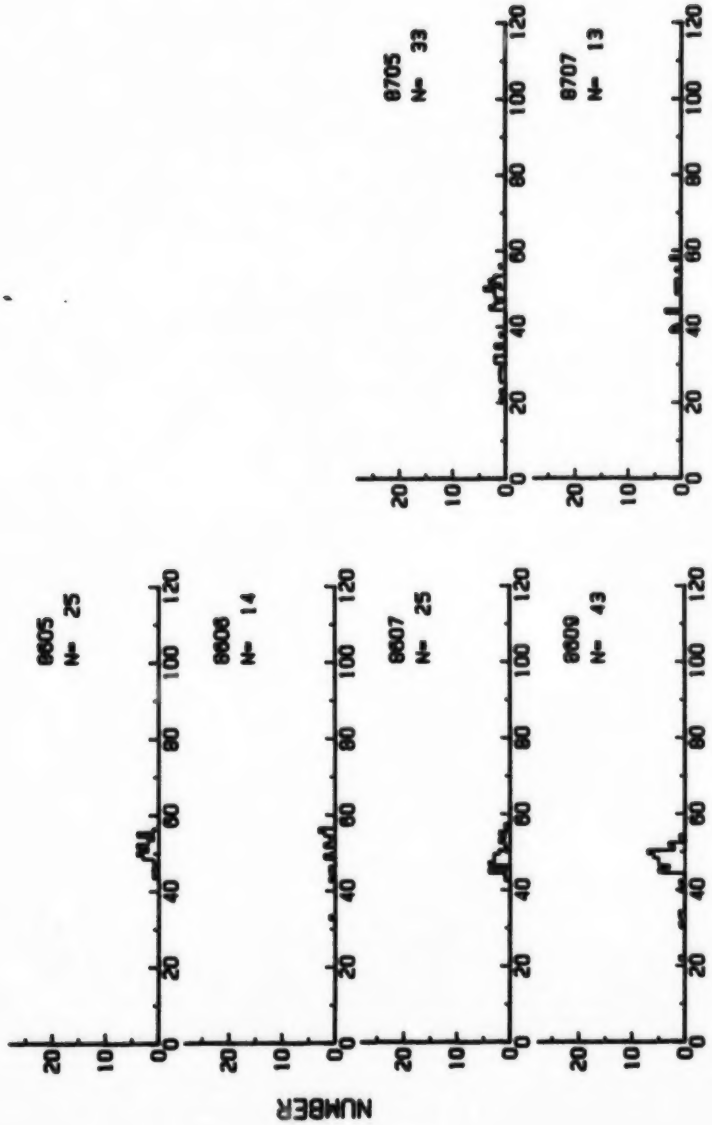


Figure 3d. Monthly length-frequency distributions for northern redbelly dace in Lake 114. All fish were caught by trap net.

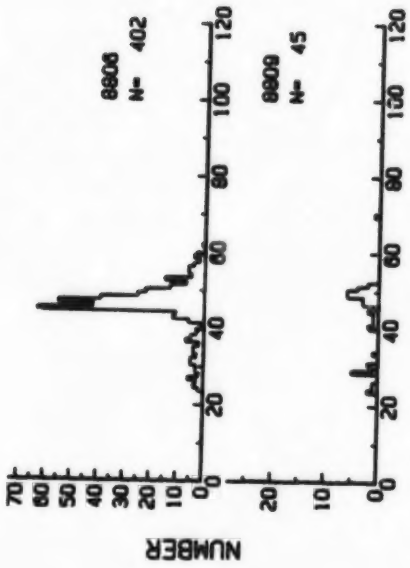


Figure 3e. Monthly length-frequency distributions for northern redbelly dace in Lake 114. All fish were caught by trap net.

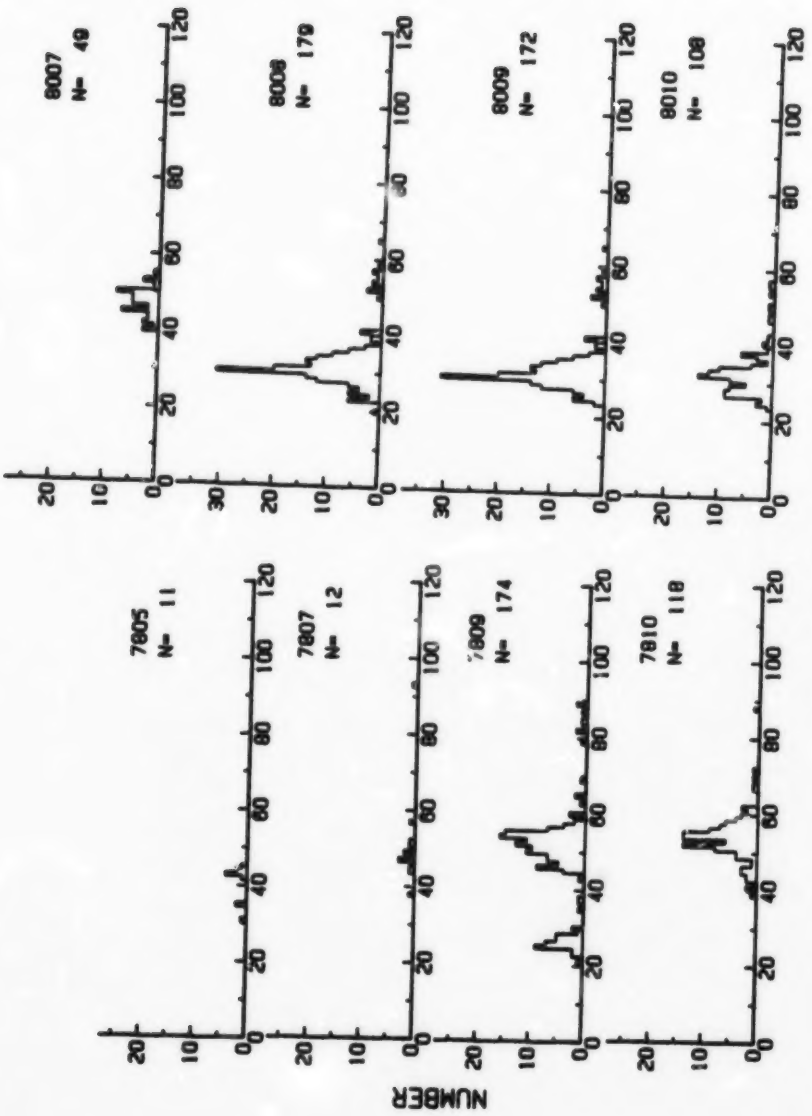


Figure 4a. Monthly length-frequency distributions for finescale dace in Lake 114. All fish were caught by trap net.

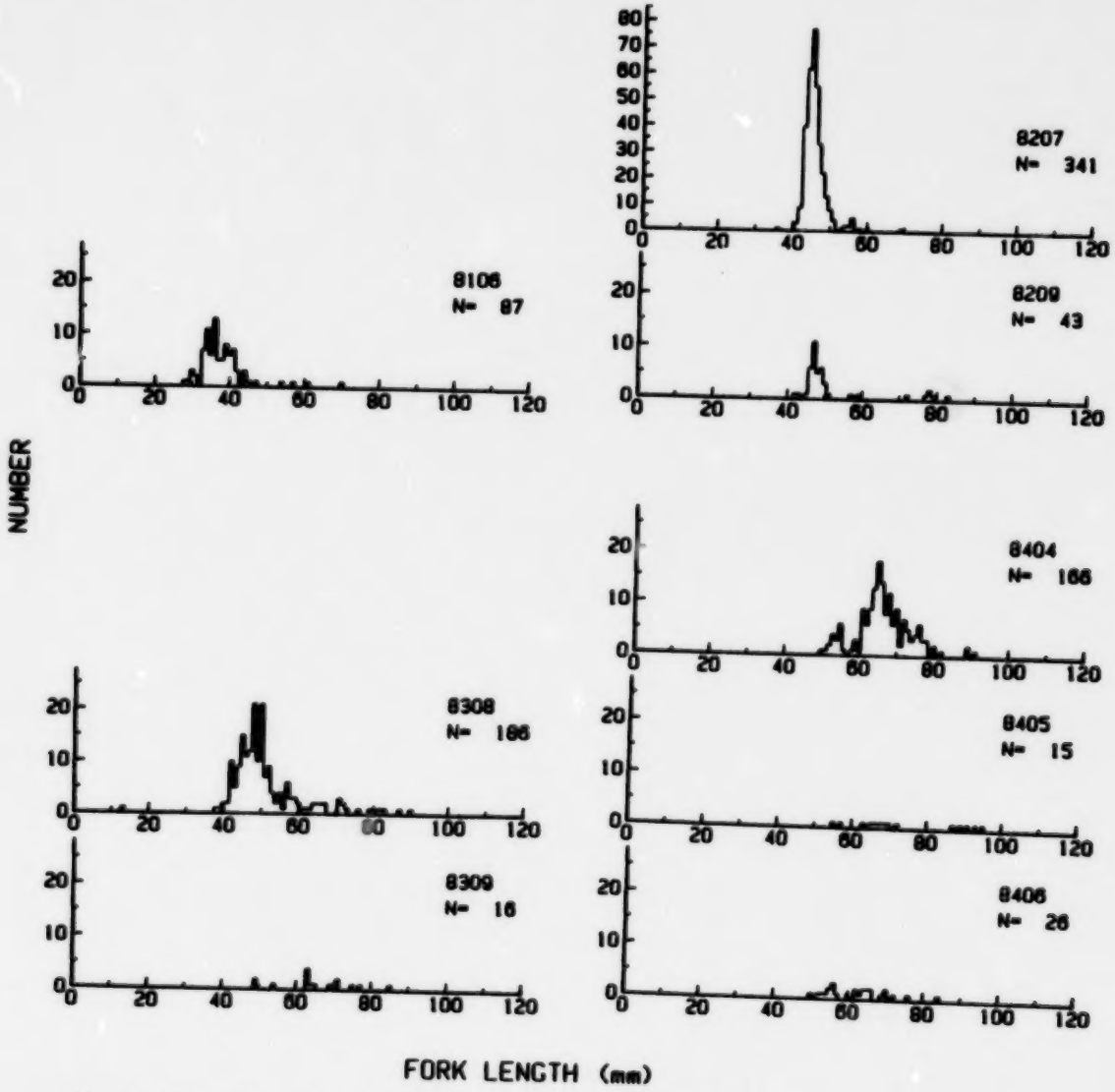


Figure 4b. Monthly length-frequency distributions for finescale dace in Lake 114. Fish captured during April 1984 (8404) were caught by minnow trap. All other fish were caught by trap net. Note change in scale of y-axis for July 1982 (8207).

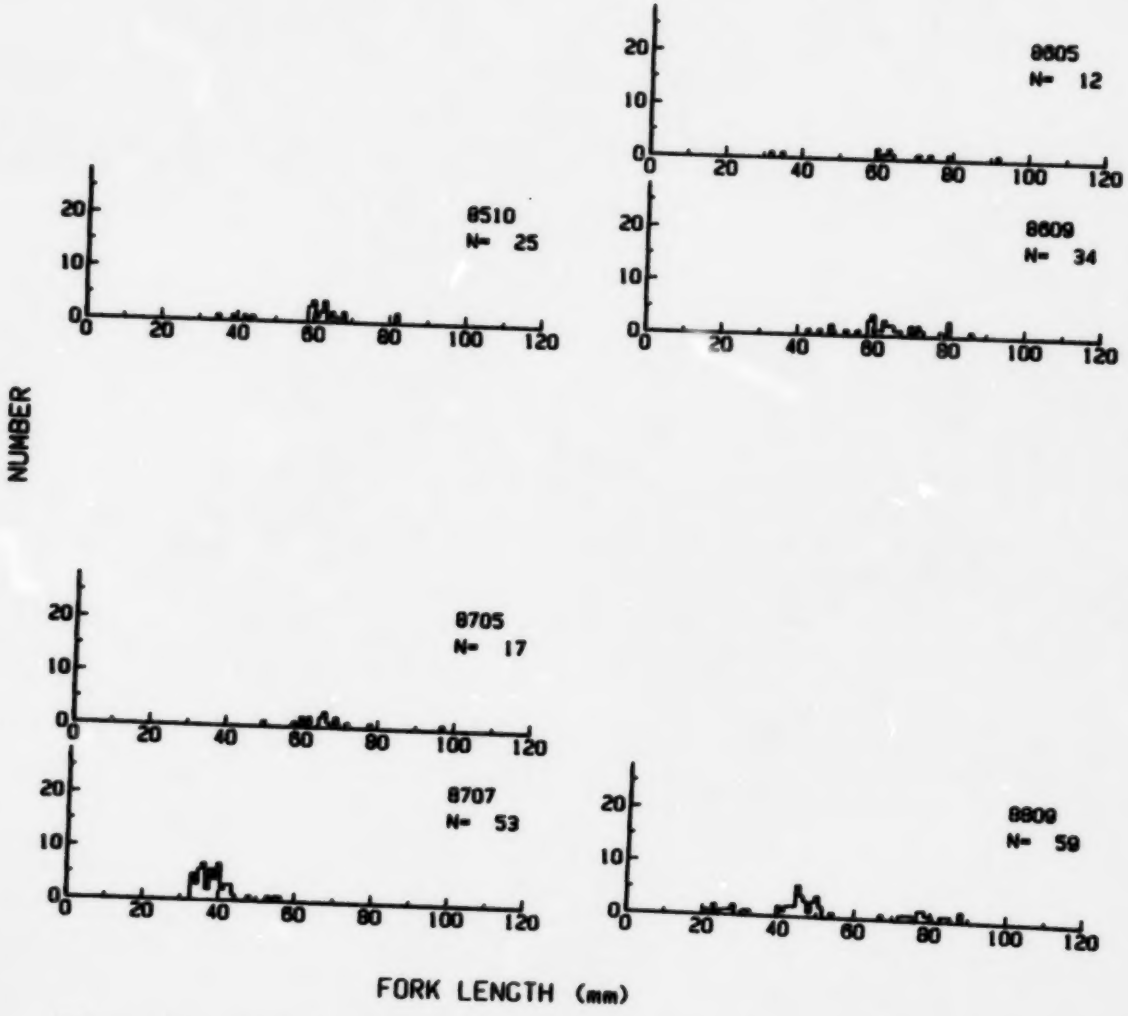


Figure 4c. Monthly length-frequency distributions for finescale dace in Lake 114. All fish were caught by trap net.

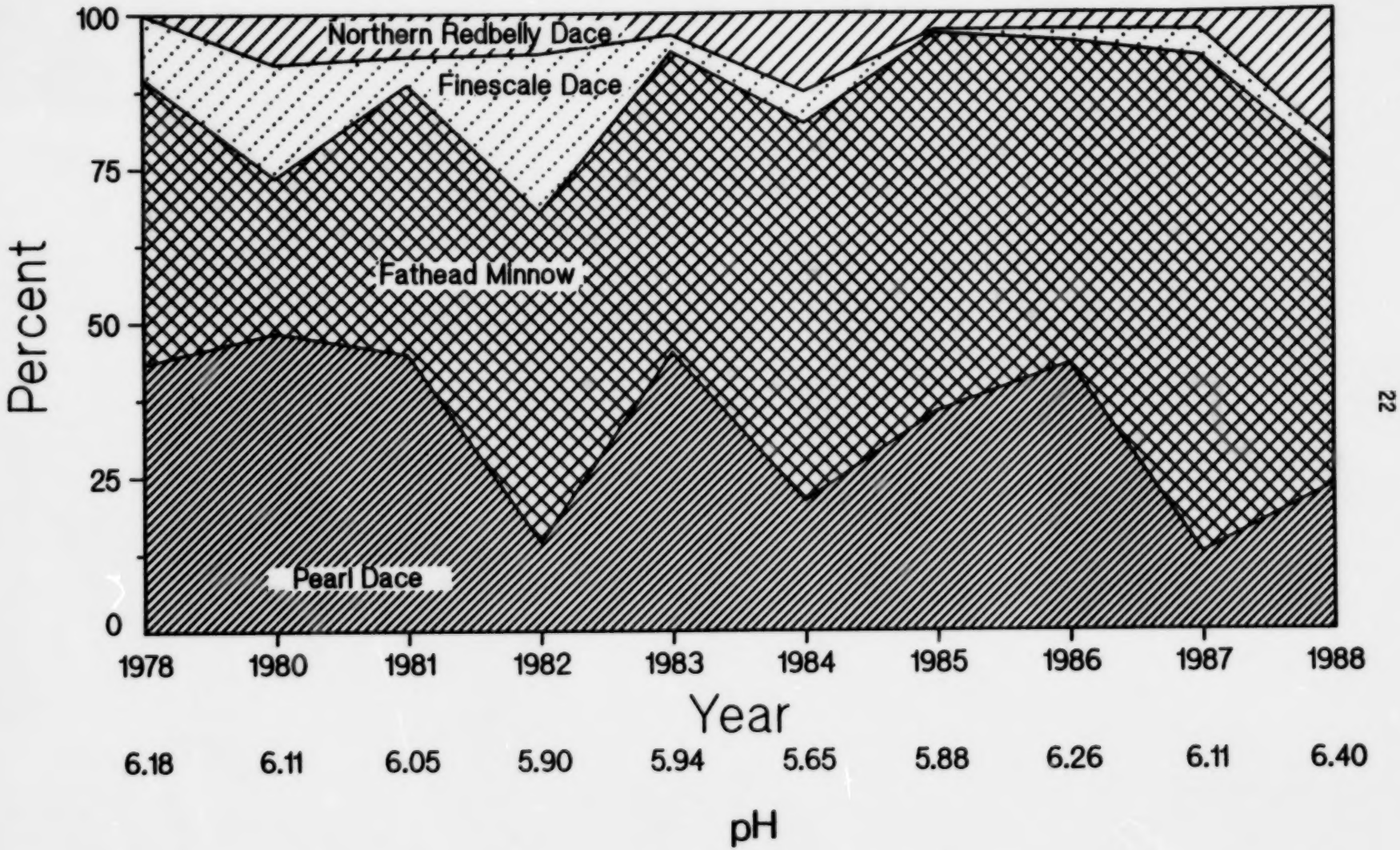


Figure 5. Annual catch composition (percentage) of Lake 114 fish. Note that data from 1979 are not on the graph.

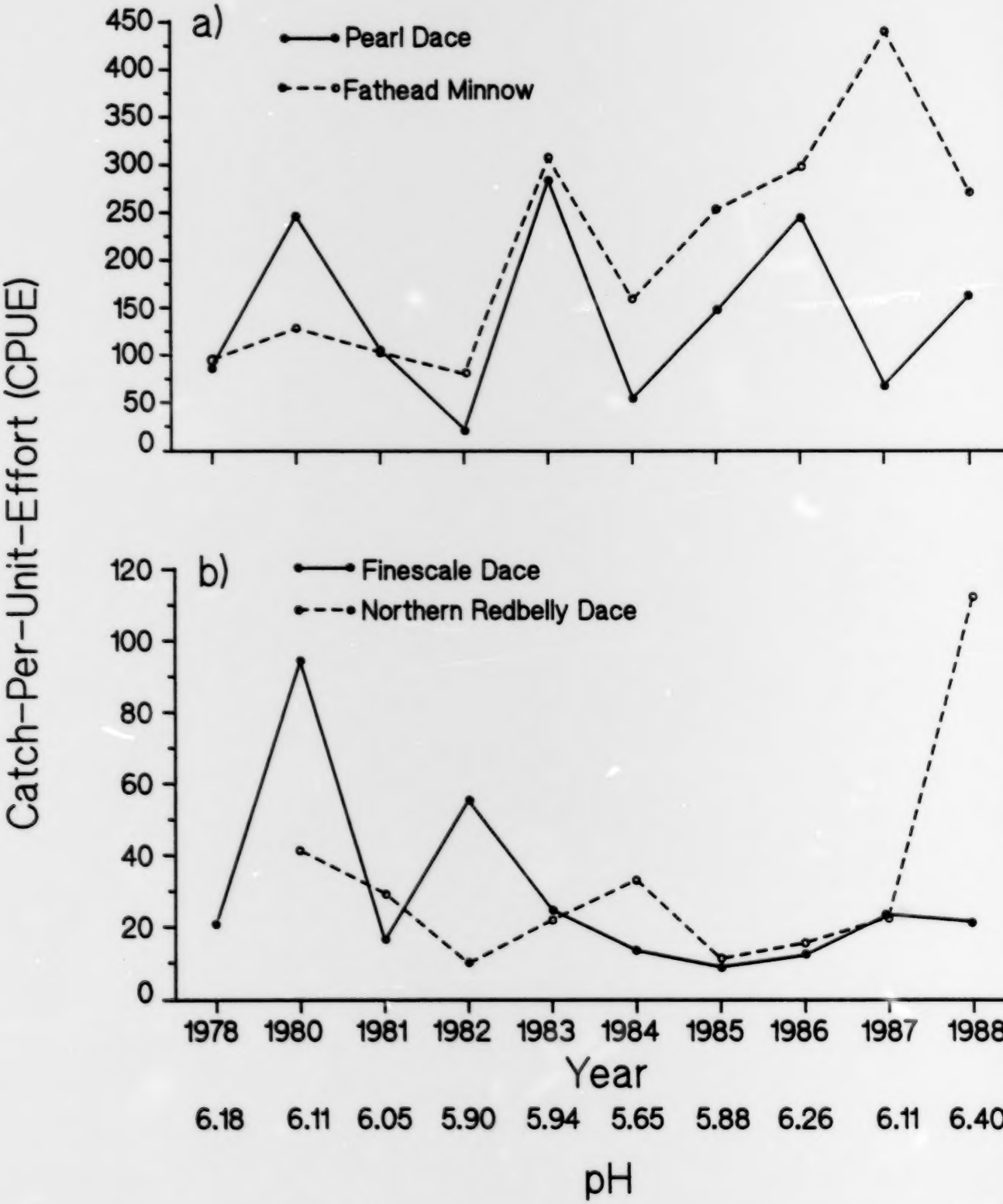


Figure 6. Catch-per-unit-effort for a) pearl dace and fathead minnow, and b) finescale dace and northern redbelly dace. Note that data for 1979 are not on the graph.